



FLORENCE COPPER INC.

1575 W. Hunt Highway, Florence, Arizona 85132 USA

florencecopper.com

October 3, 2018
File No. 132473-002

Mr. David Albright
U.S. Environmental Protection Agency
Region 9, Ground Water Office, WTR-9
75 Hawthorne Street
San Francisco, California 94105-3901

**Re: Transmittal of Summary of Geophysical Methods for Evaluating Cement Seal of
Fiberglass-Reinforced Plastic Cased Wells, Production Test Facility
Florence Copper Project, Florence Arizona**

Dear Mr. Albright:

Florence Copper Inc. herewith transmits the enclosed Technical Memorandum, *Summary of Geophysical Methods for Evaluating Cement Seal of Fiberglass-Reinforced Plastic Cased Wells, Production Test Facility, Florence Copper Project* prepared by Haley & Aldrich, Inc.

Please contact me at 520-374-3984 if you require any additional information.

Sincerely,
Florence Copper Inc.

A handwritten signature in black ink, appearing to read "Daniel Johnson", is written over a horizontal line.

Daniel Johnson
Vice President – General Manager

cc: Nancy Rumrill, U.S. Environmental Protection Agency
Maribeth Greenslade, Arizona Department of Environmental Quality

Enclosure

Taseko



HALEY & ALDRICH, INC.
One Arizona Center
400 E. Van Buren St., Suite 545
Phoenix, AZ 85004
602.760.2450

TECHNICAL MEMORANDUM

3 October 2018
File No. 132473-002

TO: Florence Copper Inc.
Dan Johnson

C: Florence Copper Inc.
Ian Ream

FROM: Haley & Aldrich, Inc.
Lauren Candreva R.G.

SUBJECT: Summary of Geophysical Methods for Evaluating Cement Seal of Fiberglass-Reinforced Plastic Cased Wells, Production Test Facility, Florence Copper

Florence Copper Inc. (Florence Copper) has constructed a Production Test Facility (PTF) at the Florence Copper Project in Florence, Arizona (Site) to demonstrate the In-situ Copper Recovery (ISCR) method for the production of copper. The PTF consists of 24 mine block wells, 7 supplemental monitoring wells, and 2 operational monitoring wells within the Permit Area of Review (AOR) defined in the Underground Injection Control (UIC) permit R9UIC-AZ3-FY11-1 issued by the United States Environmental Protection Agency (USEPA).

The 24 mine block wells consist of 4 types of wells: injection, recovery, observation, and Westbay® wells. The mine block wells are constructed using fiberglass-reinforced plastic (FRP) casing in order to provide resistance to acidic solution and to withstand the heat of hydration for the cement seal. The injection and recovery wells have an outer steel casing through the overburden that consists of larger diameter steel. The overburden casing was installed to the top of the injection zone, and was grouted from the bottom up prior to drilling and installing the inner FRP well casing. The observation and Westbay wells were installed with a single FRP casing and were grouted from the bottom up through the overburden. The observation and Westbay wells will not be used to inject or recover acid, and will only be used to collect fluid samples and water level data for operational monitoring and compliance purposes.

In accordance with Part II.C.2 of the UIC permit, Florence Copper ran sonic cement bond logs (CBLs) in steel cased wells, and the overburden casings in the injection and recovery wells. The results of those logs are summarized in the Report titled *Pre-Operational Report, Production Test Facility* (Haley & Aldrich, 2018). Part II.C.2 of the UIC Permit also requires that CBLs be run in the FRP cased wells

under the stated condition; *"if they produce useful information about the cement bond to the FRP casing and the borehole wall."*

The purpose of this document is to present information regarding the efficacy of CBLs in FRP casing. This document also provides a summary of the interpretation of the geophysical surveys that were conducted on the FRP cased wells in lieu of conventional sonic CBLs, to support the demonstration of mechanical integrity of the mine block wells.

Evaluation of Cement Bond Logs in FRP Casing

Cement integrity of steel cased wells is commonly evaluated using sonic CBLs. Sonic CBL is based on the concept of a ringing bell, when pinged with a sound pulse (typically 20 to 30 kilohertz), fluid-filled, non-cemented casing will vibrate like a bell. The amplitude of the first arriving P-Wave will be high. When bonded to cement, the amplitude will be dampened proportional to the quality of the bond and the strength of the cement. Historically, the amplitude response at a 3-foot transmitter/receiver (Tx/Rx) spacing has been used to evaluate the bond between the cement and the casing. The variable density display (VDL) of the 5-foot Tx/Rx spacing has been used to investigate a shear wave response and formation arrival to evaluate the cement to formation bond.

With non-steel casing the velocity at which the energy is transmitted through the cement and formation is faster than the velocity of the energy transmitted through the casing. Consequently, the methodology used to evaluate the cement bond to the casing and formation by evaluating the amplitude response of the sonic waveform cannot be used because the density relationship is inverted.

Method for Evaluating Annular Materials in FRP Cased Wells

After completing the evaluation of the sonic CBL, Florence Copper worked with their borehole geophysics contractor to develop a method of logging the FRP cased holes that would provide useful data regarding the cement seal in the FRP cased wells. Analysis of the CBL tool in FRP casing and development of alternate geophysical method were conducted prior to drilling and construction of the wells.

The logging suite that was determined to provide the most useful data is:

- ✧ Full Waveform Sonic (from 50 millimeters 4-Rx) – below fluid level;
- ✧ Compensated Gamma-Gamma density – entire interval; and
- ✧ 4Pi-Gamma-Gamma density – entire interval.

The full waveform sonic tool emits a sound wave and then measures the time for the wave to return to the tool, providing a velocity measurement. The differing velocities indicate different materials and in the case of FRP cased wells the first return, or fastest velocity, is the cement. The velocity across the cemented interval is relatively consistent. If the velocities vary significantly this is an indication of a change in annular material or the absence of annular material. The full waveform sonic data collection

is limited to the saturated interval (the area below the water table) and must be run centered in the casing. If the tool becomes decentered the results show a circular or helical type irregularity in the data. This log shows the presence, absence, and relative integrity of the material in the well annulus.

Compensated Gamma-Gamma density uses gamma radiation to determine the density of the material adjacent to the tool. It is run decentered, so pushed against the side of the casing, and collects data on a pie-shaped wedge. The short-spaced density measures approximately 1 to 4 inches from the tool and the long-spaced density measure approximately 8 to 12 inches from the tool. The tool can be run in dry and saturated zones and is calibrated to grams per cubic centimeter (g/cc). This log shows the density of the annular material in the immediate proximity of the tool, i.e. the grout closest to the well casing.

The 4-Pi-Gamma-Gamma density tool uses gamma radiation to measure the formation and the response of the formation is measured in counts per second (cps), it is not calibrated to g/cc. The tool measures an average response around the casing, it is impacted by fluid but can be run in dry or saturated intervals. However, the scales in the dry and saturated intervals will be different. In general, lower density material has a higher cps value and higher density has a lower cps value. This log shows the relative density of the material in the well annulus.

FIELD EVALUATION OF METHOD

During the construction of the PTF, Florence Copper took advantage of the opportunity to evaluate a FRP cased well that was suspected to have an insufficient cement seal due to equipment failures that occurred during the cementing process. During cement installation in the annulus of observation well O-05, the process could not be completed in one continuous lift due to loss of power to the grouting pump. The cement seal had to be completed the following day after the equipment was repaired. This delay resulted in partial curing of the cement seal prior to extraction of the tremie, introducing the possibility of voids in the seal, and introducing the possibility of sloughing from the borehole wall with material settling on top of the partial seal, introducing formation material into the seal when cementing resumed. The decision was made to complete the cementing operation and evaluate the integrity of the seal using geophysical methods. Cement installation was resumed the following day after the pumping equipment was repaired.

The logs collected on completed well O-05 are included as Appendix A. The density and sonic logs both indicate the bottom portion of the seal, below approximately 300 feet, has a consistent density as expected when there is a uniform annular material present, but above approximately 300 feet the density decreases and becomes irregular. The zone of lower density and irregular density was where the partially completed cement mixed with drill mud while curing prior to the resumption of the cementing process. While this well was lost, it provided an opportunity to evaluate the responses from the suite of geophysical tools used on FRP cased wells to evaluate the integrity of the cement seal. The geophysical analysis using the tools described above showed that cement seal in well O-05 did not conform to UIC well construction standards and the well was perforated through the compromised seal zone and abandoned in accordance with the procedures in Appendix C of the UIC permit.

After well O-05 was abandoned, a replacement well designated O-05B was drilled adjacent to the original well location. The same suite of geophysical logs was run at the replacement well and demonstrated adequate integrity of the cement seal. The logs from the replacement well are included in Appendix B for comparison purposes. The geophysical logs for the failed well O-05 (Appendix A) show geophysical results for a compromised cement seal, and logs for the replacement well O-05B (Appendix B) show geophysical results for a seal with good continuity and integrity.

Conclusions

The geophysical logging suite used to evaluate the FRP cased wells includes the best available technologies to evaluate cement seal characteristics in FRP cased wells. The combined use of these geophysical tools yields analysis demonstrating the continuity, bulk density, and focused density of the cement seals in the FRP cased wells. These geophysical tools yield a suite of data describing the density of annular materials behind FRP casing that is analogous to the CBL conducted in steel casing, and facilitate the evaluation of seal integrity in accordance with requirements of Part II.C.2 of the UIC Permit.

References

Crowder, R.E. and Henrich, W.J., 1994, **"Monitoring Well Completion Evaluation With Borehole Geophysical Methods"**, Proceedings of Symposium on the Application of Geophysics to Environmental and Engineering Problems, March 27-31, 1994, Boston, Massachusetts, pp 405-422.

J.L. De Paula, V.F. Rodrigues, and R. Vicente, Petróleo Brasileiro, 2007, **Cement Sheath Evaluation in Nonconventional Environment—Case History**, 2007 SPE Annual Technical Conference and Exhibition held in Anaheim, California, U.S.A., 11–14 November 2007

Yearsley, E.N., Crowder, R.E., and Irons, L.A., **"Monitoring Well Completion Evaluation with Borehole Geophysical Density Logging"**, Winter 1991 Issue of Ground Water Monitoring Review.

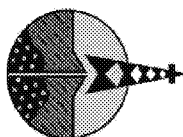
Enclosures:

Appendix A – Geophysical Logs for Well O-05

Appendix B – Geophysical Logs for Well O-05B

APPENDIX A

Geophysical Logs for Well O-05



Southwest Exploration Services, LLC

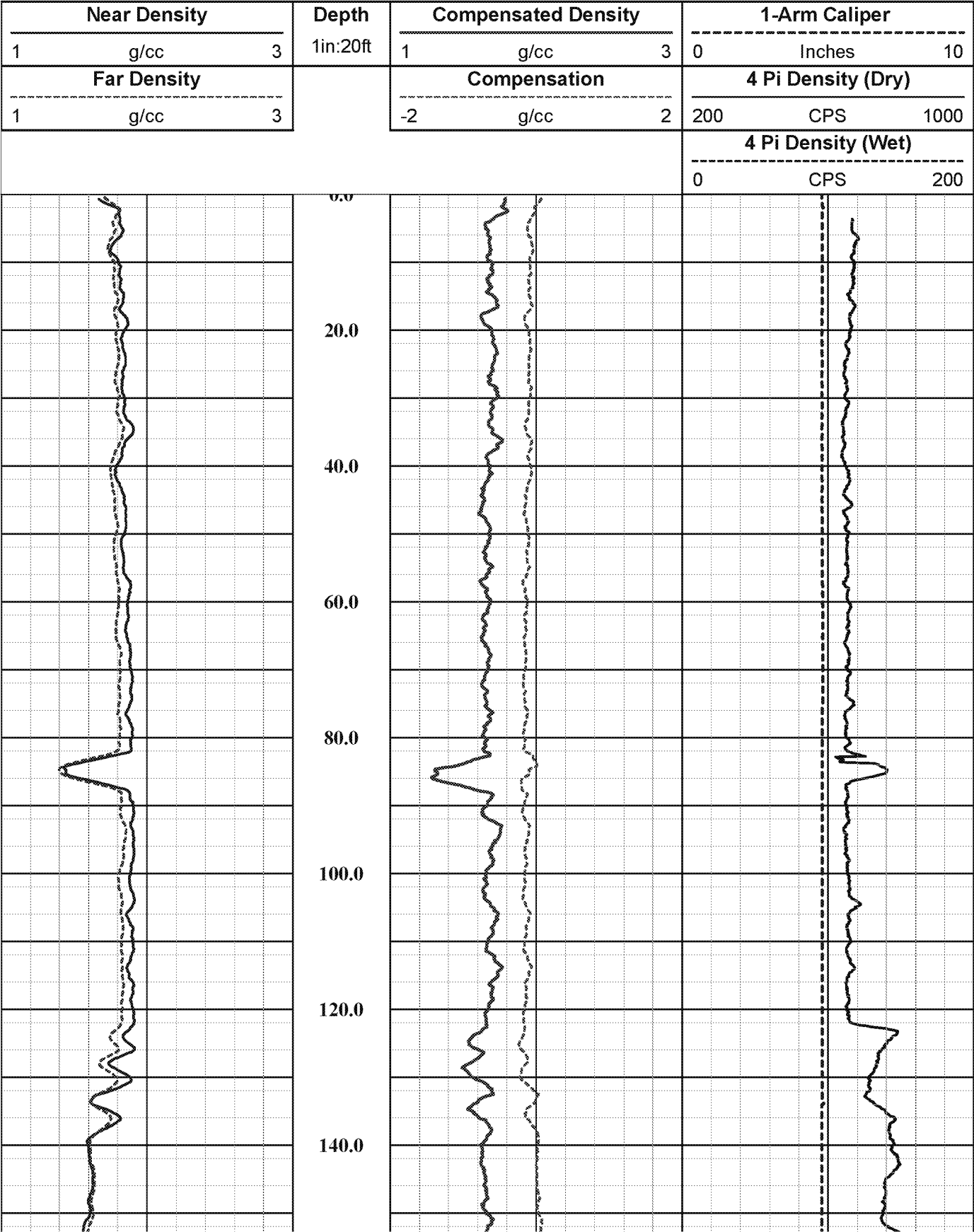
borehole geophysics & video services

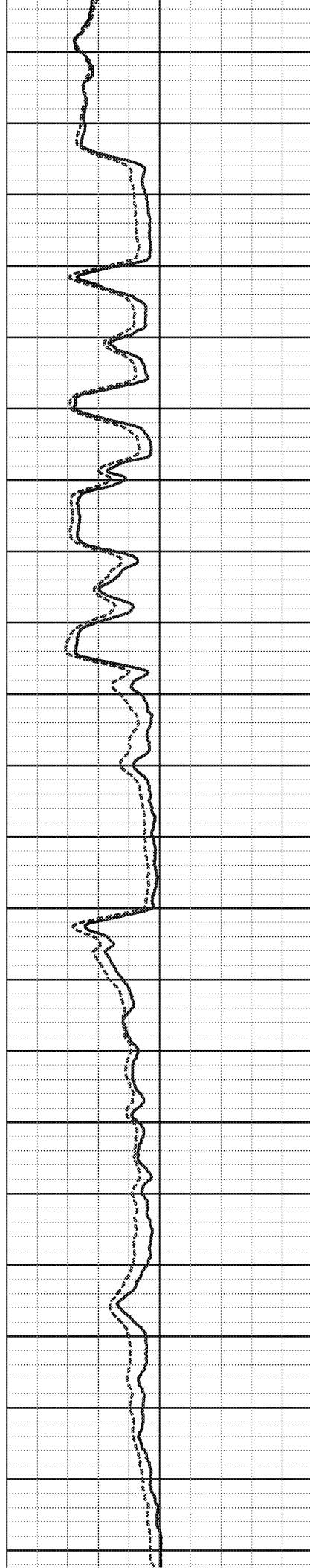
COMPANY		FLORENCE COPPER		WELL ID		O-05		FIELD		FLORENCE COPPER		COUNTY		PINAL		STATE		ARIZONA			
TYPE OF LOGS: DUAL DENSITY MORE: 4 PI DENSITY										OTHER SERVICES NAT. GAMMA 3-ARM CALIPER TEMPERATURE SONIC ACOUSTIC TELEVIEWER											
LOCATION																					
PERMANENT DATUM		SEC		TWP		RGE		ELEVATION		K.B.											
LOG MEAS. FROM		GROUND LEVEL		ABOVE PERM. DATUM		D.F.		DRILLING MEAS. FROM		GROUND LEVEL		G.L.									
DATE		06-06-17		TYPE FLUID IN HOLE		FORMATION WATER															
RUN No		2 & 3		MUD WEIGHT		N/A															
TYPE LOG		DUAL DENSITY - 4 PI		VISCOSITY		N/A															
DEPTH-DRILLER		1203.0 FT.		LEVEL		~ 262.0 FT.															
DEPTH-LOGGER		1196.0 FT.		MAX. REC. TEMP.		39.38 DEG. C															
BITM LOGGED INTERVAL		1196.0 FT.		IMAGE ORIENTED TO:		N/A															
TOP LOGGED INTERVAL		SURFACE		SAMPLE INTERVAL		0.2 FT															
DRILLER / RIG#		NATIONAL DRILLING		LOGGING TRUCK		TRUCK #310															
RECORDED BY / Logging Eng.		A. OLSON / M. QUINONES		TOOL STRING/SN		MSI 2GDA SN 3083															
WITNESSED BY		CHAD - H & A		LOG TIME: ON SITE/OFF SITE		3:00 P.M.															
RUN		BOREHOLE RECORD		CASING RECORD																	
NO.		BIT FROM		TO		SIZE		WGT.		FROM		TO									
1		12 1/4 IN.		SURFACE		TOTAL DEPTH		5 IN.		F. GLASS		SURFACE		511 FT.							
2								5 IN.		PVC		511 FT.		TOTAL DEPTH							
3																					
COMMENTS:																					

Tool Summary:					
Date	06-06-17	Date	06-06-17	Date	06-06-17
Run No.	1	Run No.	2	Run No.	3
Tool Model	MSI COMBO TOOL	Tool Model	MSI DENSITY	Tool Model	COMPROBE 4 PI
Tool SN	4953	Tool SN	3083	Tool SN	6009
From	SURFACE	From	SURFACE	From	250.0 FT.
To	1196.0 FT.	To	560.0 FT.	To	560.0 FT.
Recorded By	A. OLSON	Recorded By	A. OLSON	Recorded By	A. OLSON
Truck No	310	Truck No	310	Truck No	310
Operation Check	06-05-17	Operation Check	06-05-17	Operation Check	06-05-17
Calibration Check	06-05-17	Calibration Check	N/A	Calibration Check	N/A
Time Logged	3:05 P.M.	Time Logged	4:15 P.M.	Time Logged	4:45 P.M.
Date	06-06-17	Date	06-06-17	Date	
Run No.	4	Run No.	5	Run No.	6
Tool Model	ALT 4 RX SONIC	Tool Model	ALT QL ABI40 2G	Tool Model	
Tool SN	5185	Tool SN	143002	Tool SN	
From	SURFACE	From	260.0 FT.	From	
To	560.0 FT.	To	1192.0 FT.	To	
Recorded By	A. OLSON	Recorded By	A. OLSON	Recorded By	
Truck No	310	Truck No	310	Truck No	
Operation Check	06-05-17	Operation Check	06-05-17	Operation Check	
Calibration Check	N/A	Calibration Check	N/A	Calibration Check	
Time Logged	5:15 P.M.	Time Logged	6:00 P.M.	Time Logged	
Additional Comments:					
Caliper Arms Used: 3"					
Calibration Points: 2" & 4"					

Disclaimer:

All interpretations of log data are opinions based on inferences from electrical or other measurements. We do not guarantee the accuracy or correctness of any interpretations or recommendations and shall not be liable or responsible for any loss, costs, damages, or expenses incurred or sustained by anyone resulting from any interpretation made by any of our employees or agents. These interpretations are also subject to our general terms and conditions set out in our current Service Invoice.





160.0

180.0

200.0

220.0

240.0

260.0

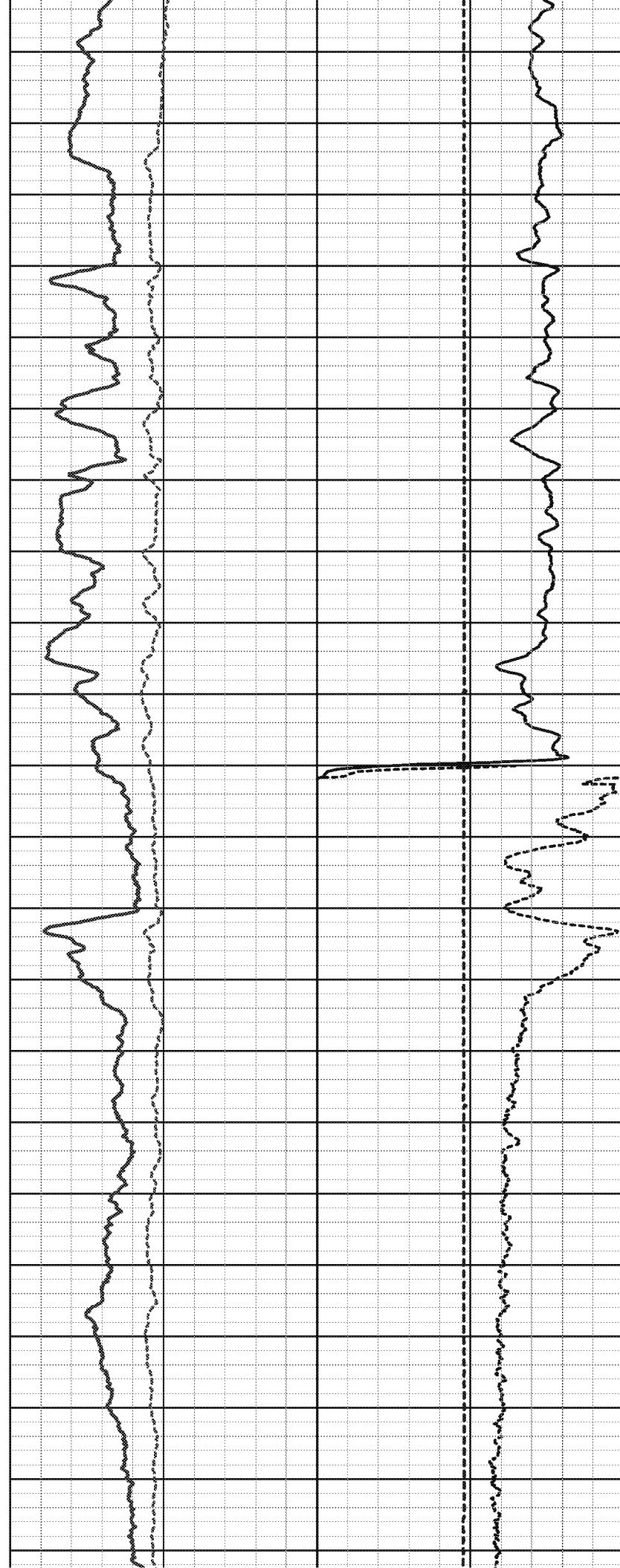
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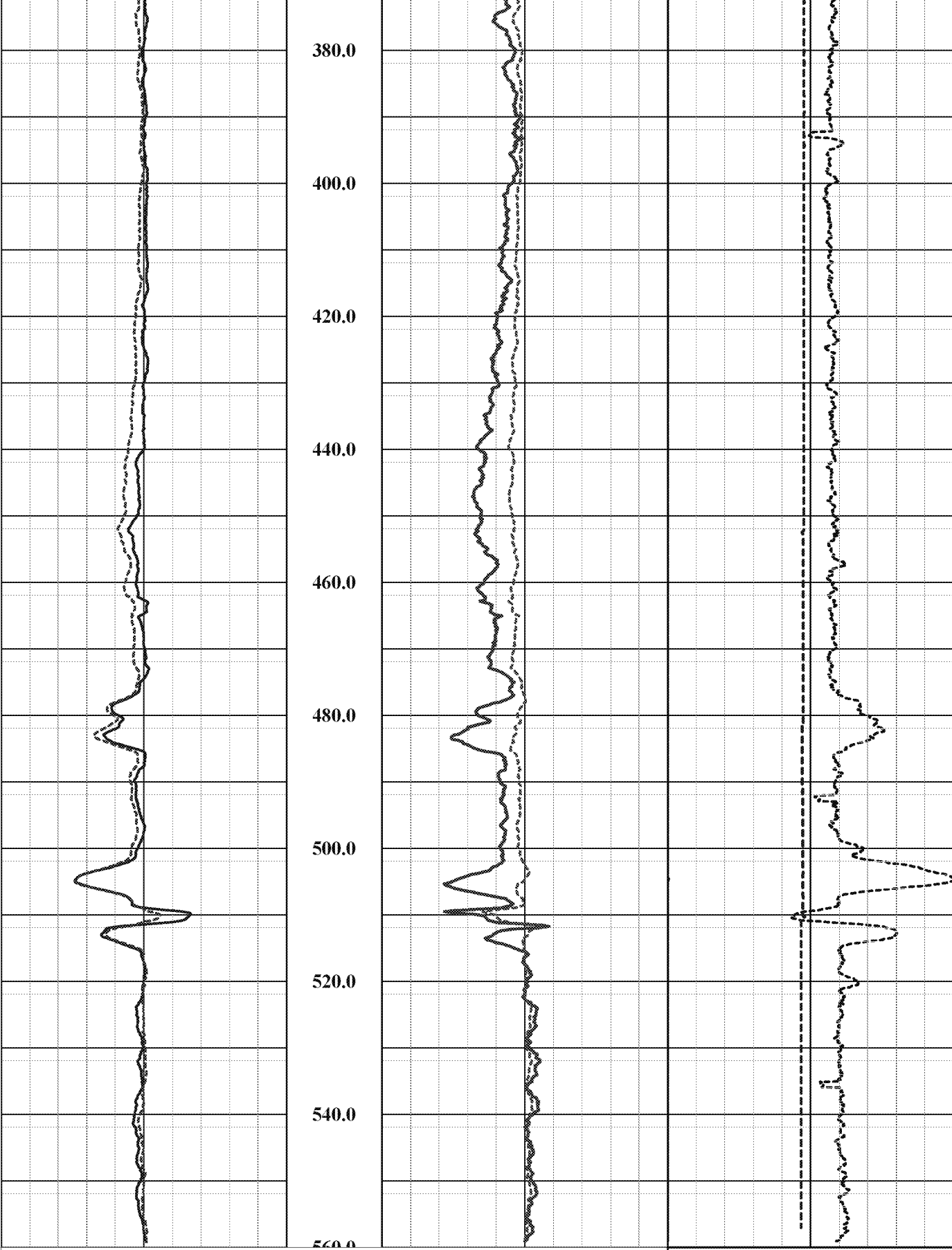
300.0

320.0

340.0

360.0





1 g/cc 3		-2 g/cc 2		0 CPS 200
Far Density		Compensation		4 Pi Density (Wet)
1 g/cc 3		1 g/cc 3		200 CPS 1000
Near Density		Compensated Density		4 Pi Density (Dry)
1 g/cc 3		1 g/cc 3		0 Inches 10
Depth		1 in:20ft		1-Arm Caliper

MSI 2GDA Density

Probe Top = Depth Ref.

Tool SN: 3082, 3925, & 5273

Single Conductor MSI Probe Top

Probe Length = 3.20 m or 10.50 ft

Probe Weight = 17.3 kg or 38.14 lbs

2GDA can only be collected logging up hole due to the caliper.

Temperature Rating: 70 Deg C (158 Deg F)

Pressure Rating: 200 bar (2900 psi)

Guard Resistivity = 1.11 m (43.74 in)

1-Arm Caliper = 0.79 m (31.0 in)

Decentralization Band

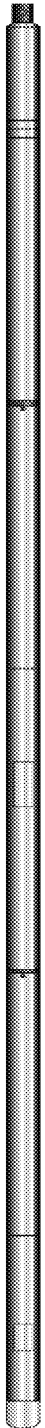
Near/Far Detectors

Source

Source
1.60" or 41.0 mm Diameter

4 Pi Density Tool SN 6009

Probe Top = Depth Ref.



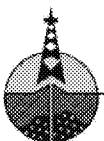
— Four Conductor Probe Top

Probe Length = 1.57 m or 5.17 ft
Probe Weight = 4.99 kg or 11.0 lbs

Uses an Cs 137 Radioactive Source
Detector Assembly: NaI crystal with Photo-tube

Temperature Rating: 107 Deg C (225 Deg F)
Pressure Rating: 344.7 bar (5000 psi)

1.25 in or 31.75 mm Diameter



**Southwest Exploration
Services, LLC**

borehole geophysics & video services

Company

FLORENCE COPPER

Well

O-05

Field

FLORENCE COPPER

County

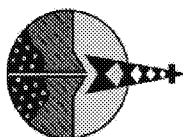
PINAL

State

ARIZONA

ED_002245_00000061-00012

	State	ARIZONA
Final	Dual Density - 4 PI Summary	



Southwest Exploration Services, LLC

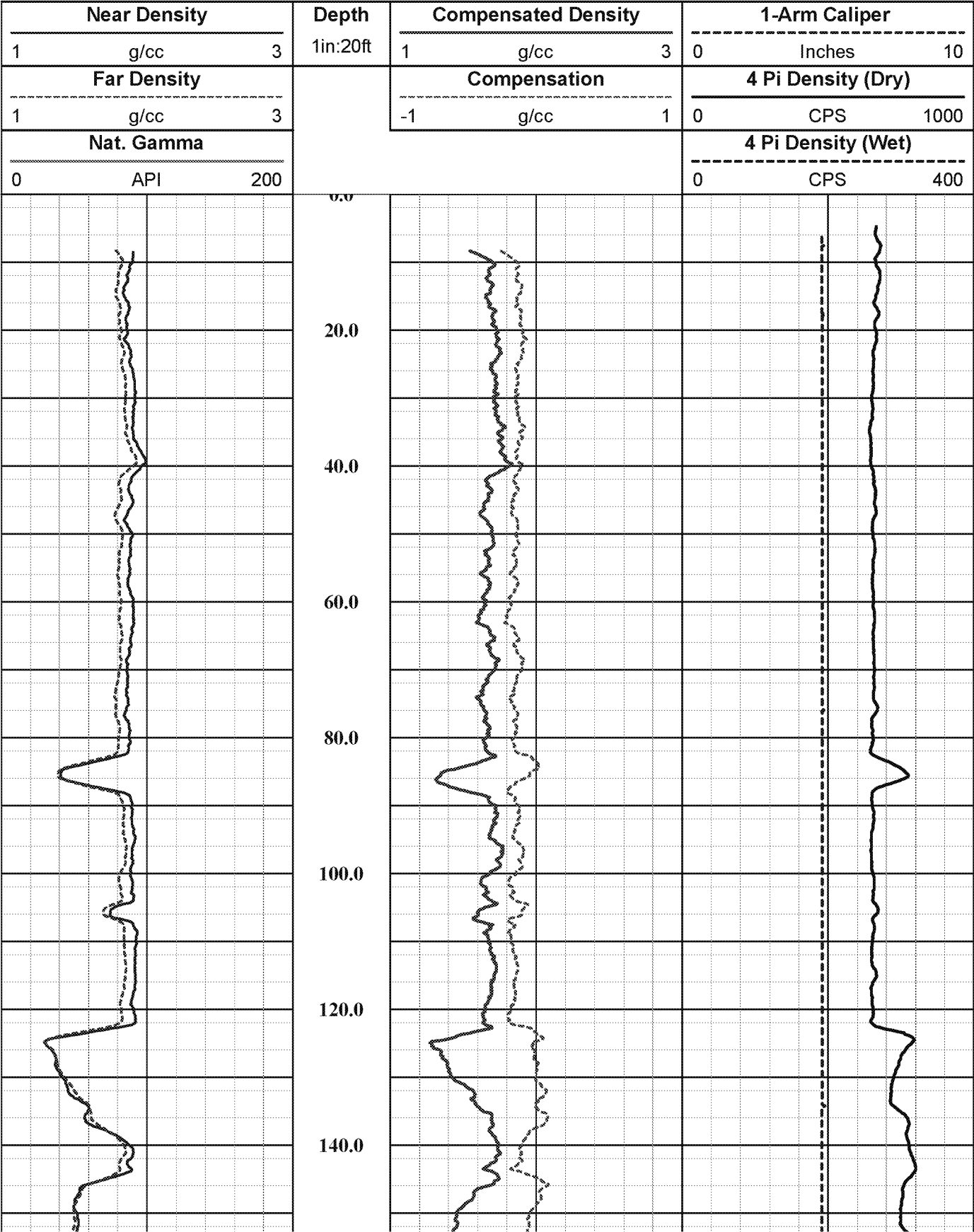
borehole geophysics & video services

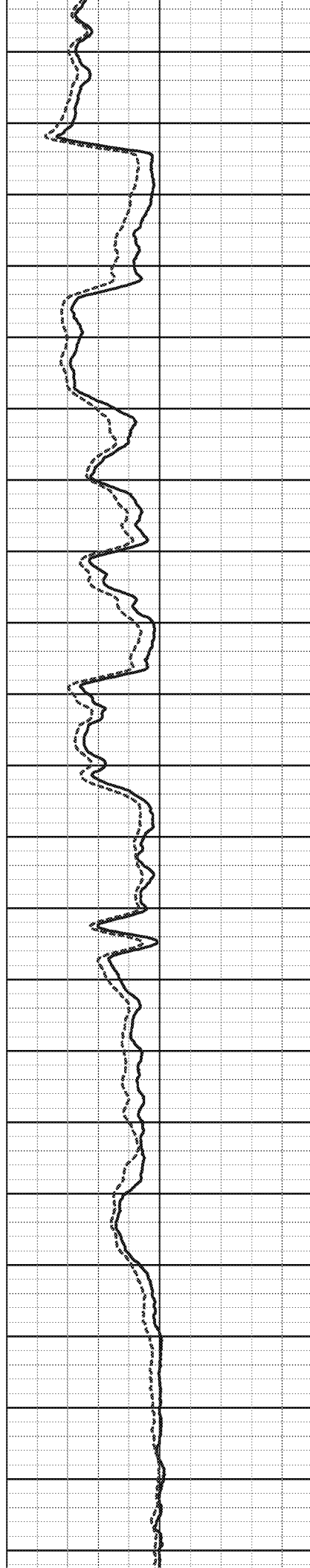
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TYPE OF LOGS: DUAL DENSITY MORE: 4 PI DENSITY		LOCATION		OTHER SERVICES SONIC					
PERMANENT DATUM		SEC		TWP		RGE		ELEVATION	
LOG MEAS. FROM		GROUND LEVEL		ABOVE PERM. DATUM		D.F.		G.L.	
DRILLING MEAS. FROM		GROUND LEVEL		DATE		6-12-17		TYPE FLUID IN HOLE	
RUN No		1 & 3		MUD WEIGHT		N/A		FORMATION WATER	
TYPE LOG		DUAL DENSITY-4 PI DENS.		VISCOSITY		N/A			
DEPTH-DRILLER		1203 FT		LEVEL		~ 250 FT			
DEPTH-LOGGER		1196 FT		MAX. REC. TEMP.		N/A			
BTM LOGGED INTERVAL		560 FT		IMAGE ORIENTED TO:		N/A			
TOP LOGGED INTERVAL		SURFACE		SAMPLE INTERVAL		0.2 FT			
DRILLER / RIG#		NATIONAL DRILLING		LOGGING TRUCK		TRUCK #310			
RECORDED BY / Logging Eng.		M. QUINONES / E. TURNER		TOOL STRING/SN		MSI 2GDA SN 3083			
WITNESSED BY		NATIONAL		LOG TIME: ON SITE/OFF SITE		10:20 AM			
RUN NO.		BOREHOLE RECORD		CASING RECORD		TO			
BIT		FROM		TO		SIZE		WGT.	
1		12 1/4 IN.		SURFACE		TOTAL DEPTH		5 IN.	
2						5 IN.		F. GLASS	
3						PVC		511 FT	
COMMENTS:									

Tool Summary:					
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Run No.	1	Run No.	2	Run No.	3
Tool Model	MSI 2GDA	Tool Model	ALT 4 RX SONIC	Tool Model	COMPROB 4 PI
Tool SN	3083	Tool SN	5185	Tool SN	6009
From	SURFACE	From	278 FT	From	SURFACE
To	560 FT	To	560 FT	To	560 FT
Recorded By	M. QUINONES	Recorded By	M. QUINONES	Recorded By	M. QUINONES
Truck No	310	Truck No	310	Truck No	310
Operation Check	6-12-17	Operation Check	6-12-17	Operation Check	6-12-17
Calibration Check	6-12-17	Calibration Check	N/A	Calibration Check	N/A
Time Logged	10:45 AM	Time Logged	11:25 AM	Time Logged	11:45 AM
Date		Date		Date	
Run No.	4	Run No.	5	Run No.	6
Tool Model		Tool Model		Tool Model	
Tool SN		Tool SN		Tool SN	
From		From		From	
To		To		To	
Recorded By		Recorded By		Recorded By	
Truck No		Truck No		Truck No	
Operation Check		Operation Check		Operation Check	
Calibration Check		Calibration Check		Calibration Check	
Time Logged		Time Logged		Time Logged	
Additional Comments:					
Caliper Arms Used: N/A					
Calibration Points: N/A					

Disclaimer:

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160.0

180.0

200.0

220.0

240.0

260.0

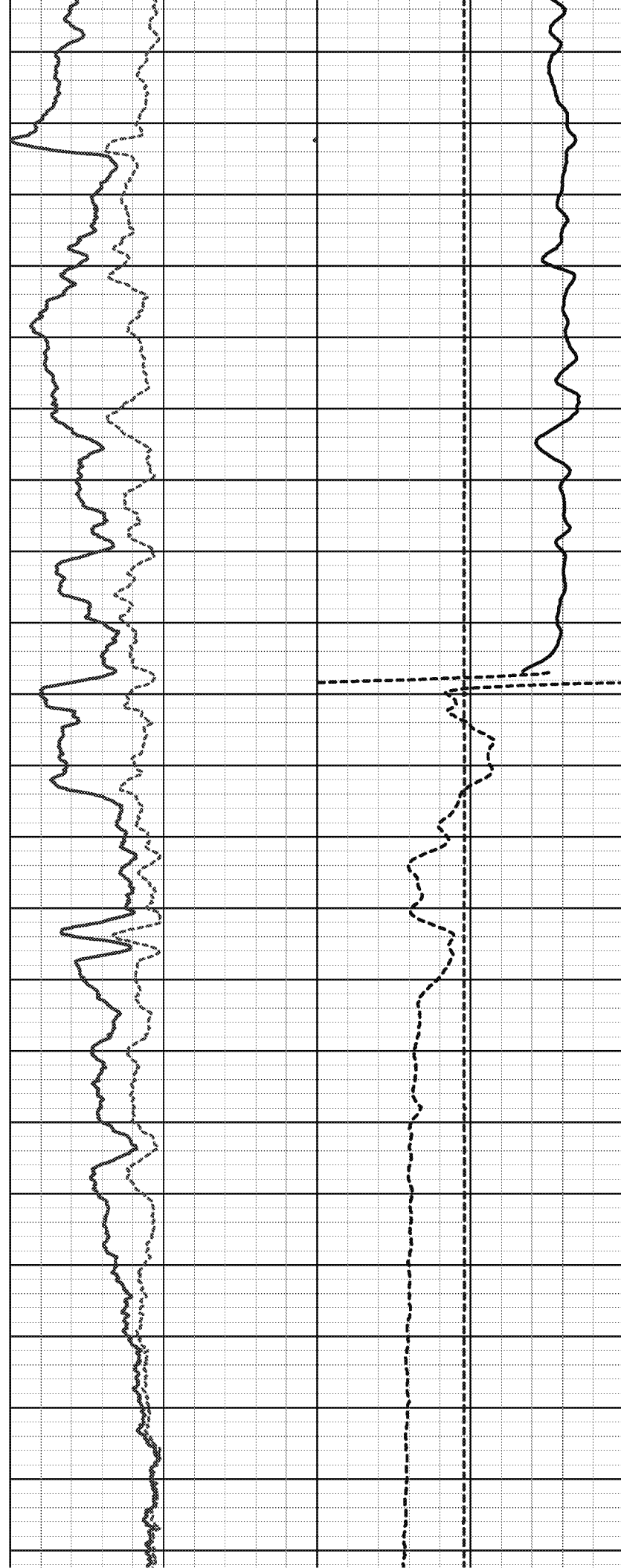
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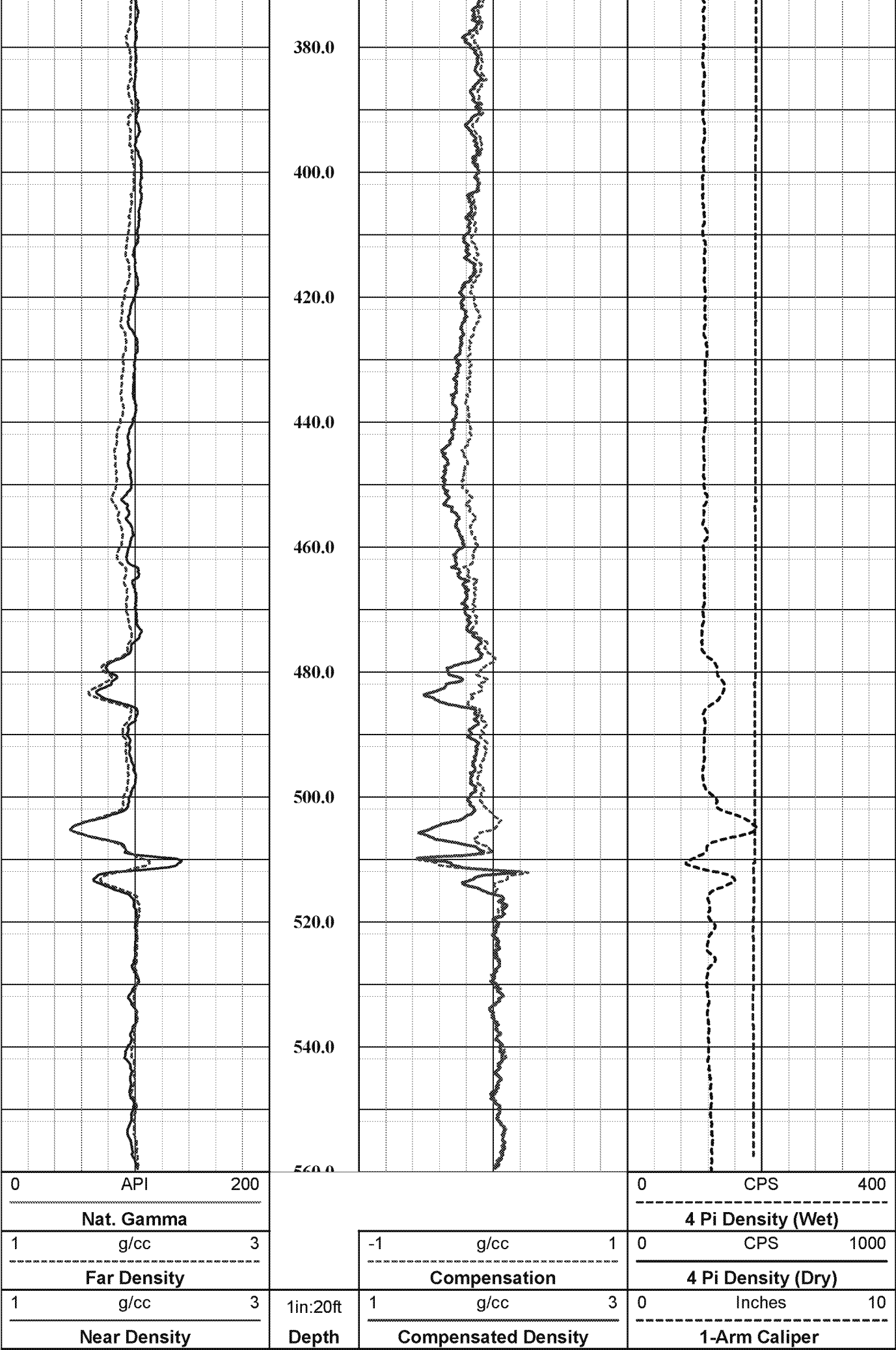
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MSI 2GDA Density

Probe Top = Depth Ref.

Tool SN: 3082, 3925, & 5273

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Probe Length = 3.20 m or 10.50 ft

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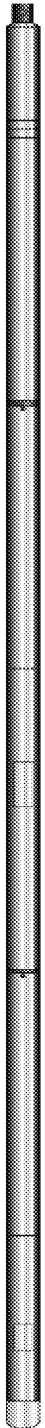
Near/Far Detectors

Source

Source
1.60" or 41.0 mm Diameter

4 Pi Density Tool SN 6009

Probe Top = Depth Ref.



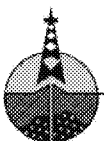
— Four Conductor Probe Top

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Detector Assembly: NaI crystal with Photo-tube

Temperature Rating: 107 Deg C (225 Deg F)
Pressure Rating: 344.7 bar (5000 psi)

1.25 in or 31.75 mm Diameter



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borehole geophysics & video services

Company

FLORENCE COPPER

Well

O-05

Field

FLORENCE COPPER

County

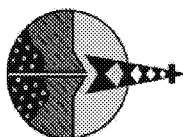
PINAL

State

ARIZONA

ED_002245_00000061-00019

	State	ARIZONA
Final	Dual Density / 4 Pi Density Summary	



Southwest Exploration Services, LLC

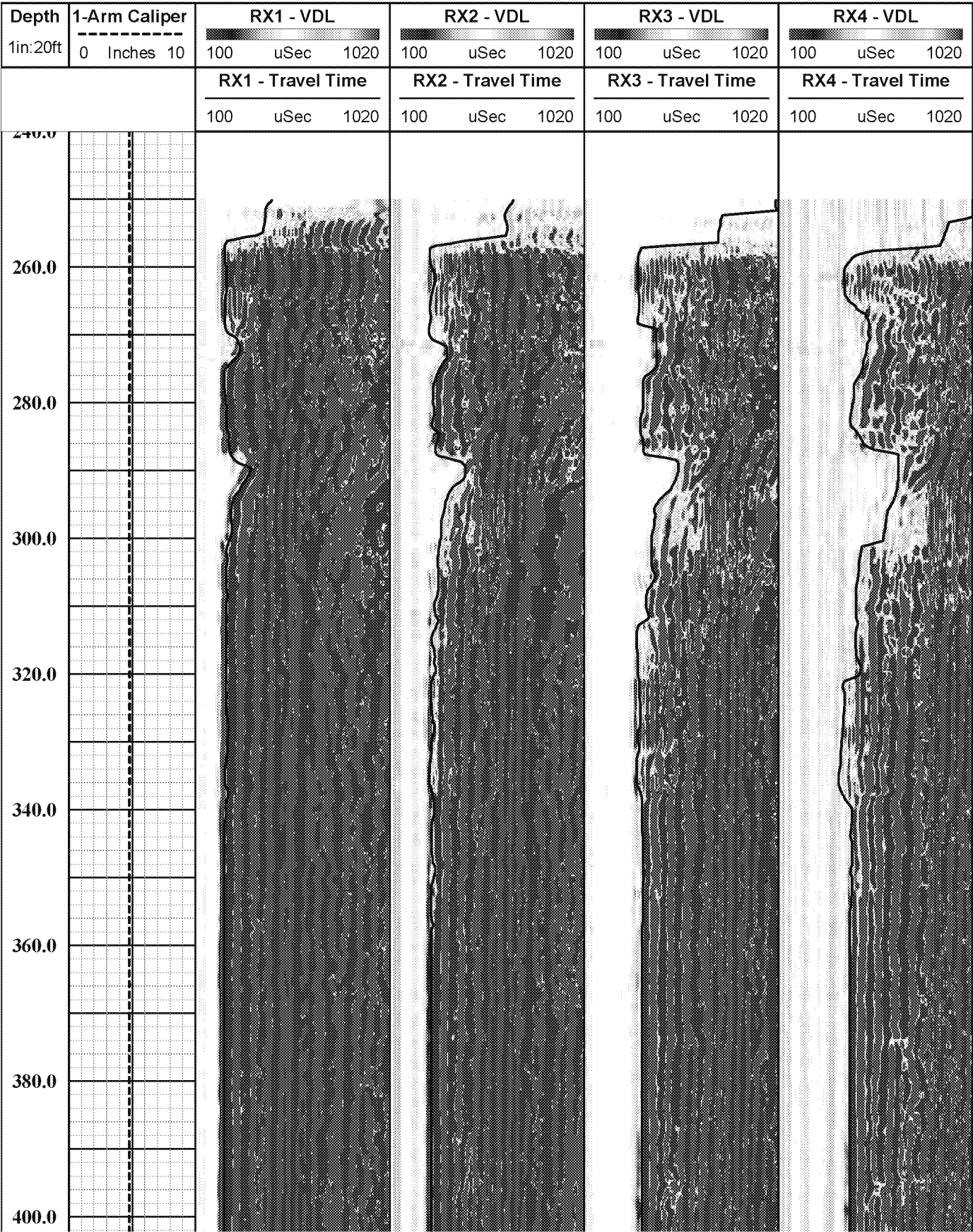
borehole geophysics & video services

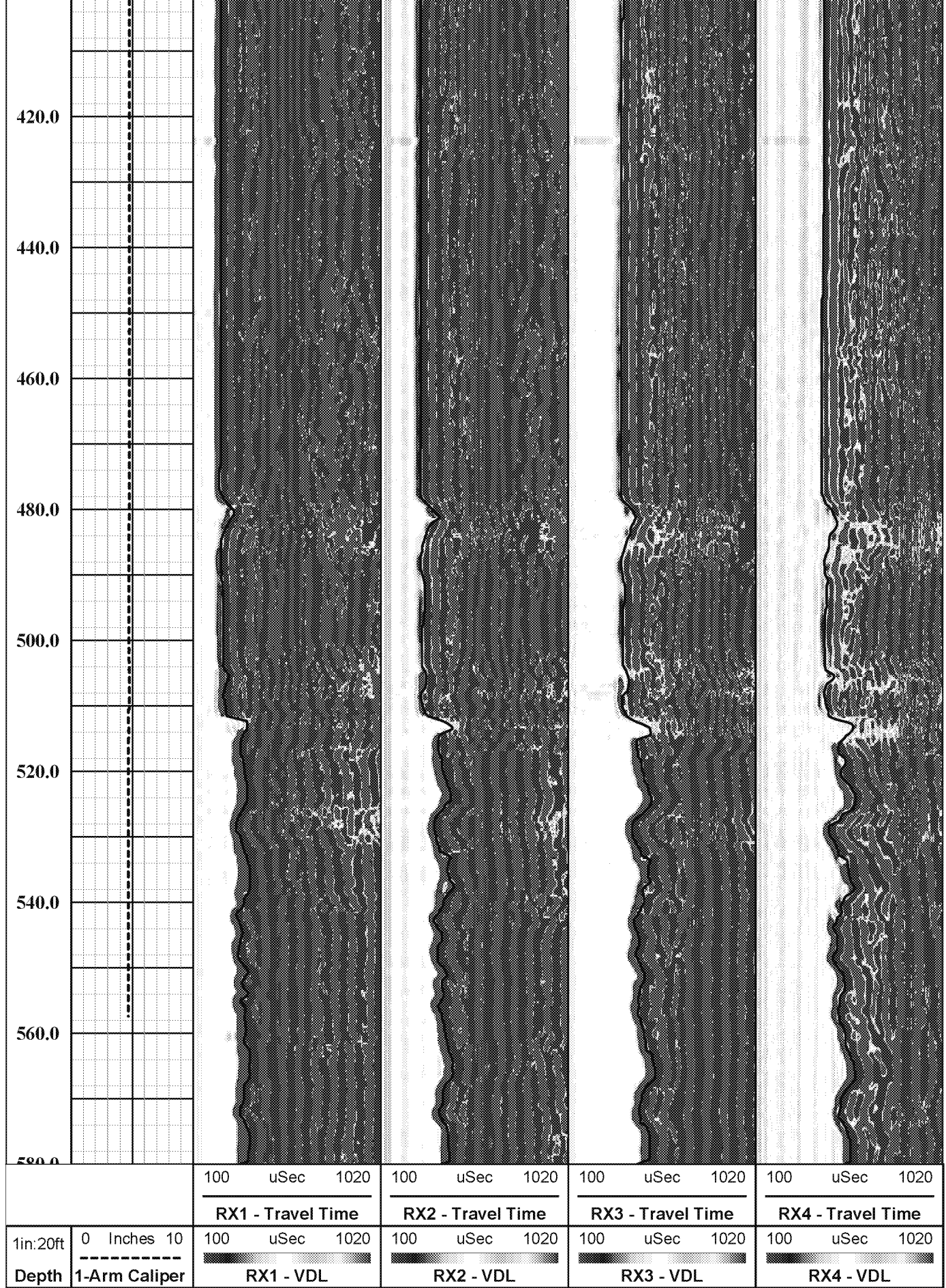
COMPANY FLORENCE COPPER		WELL ID O-05		FIELD FLORENCE COPPER		COUNTY PINAL		STATE ARIZONA	
TYPE OF LOGS: ALT 4RX SONIC MORE: 1 ARM CALIPER		LOCATION		OTHER SERVICES DUAL DENSITY 4 PI DENSITY					
PERMANENT DATUM		SEC	TWP	RGE	ELEVATION				
LOG MEAS. FROM		GROUND LEVEL		ABOVE PERM. DATUM		K.B. D.F.			
DRILLING MEAS. FROM		GROUND LEVEL				G.L.			
DATE	6-12-17	TYPE FLUID IN HOLE		FORMATION WATER					
RUN No	1 & 2	MUD WEIGHT		N/A					
TYPE LOG	SONIC-1 ARM CALIPER	VISCOSITY		N/A					
DEPTH-DRILLER	1203 FT	LEVEL		~ 250 FT					
DEPTH-LOGGER	1196 FT	MAX. REC. TEMP.		N/A					
BTM LOGGED INTERVAL	560 FT	IMAGE ORIENTED TO:		N/A					
TOP LOGGED INTERVAL	SURFACE	SAMPLE INTERVAL		0.25 FT					
DRILLER / RIG#	NATIONAL DRILLING	LOGGING TRUCK		TRUCK #310					
RECORDED BY / Logging Eng.	M. QUINONES / E. TURNER	TOOL STRING/SN		ALT 4RX SONIC SN 5185					
WITNESSED BY	NATIONAL	LOG TIME: ON SITE/OFF SITE		10:20 AM					
BOREHOLE RECORD		CASING RECORD							
NO.	BIT	FROM	TO	SIZE	WGT.	FROM	TO		
1	12 1/4 IN.	SURFACE	TOTAL DEPTH	5 IN.	F. GLASS	SURFACE	511 FT		
2				5 IN.	PVC	511 FT	TOTAL DEPTH		
3									
COMMENTS:									

Tool Summary:					
Date	6-12-17	Date	6-12-17	Date	6-12-17
Run No.	1	Run No.	2	Run No.	3
Tool Model	MSI 2GDA	Tool Model	ALT 4 RX SONIC	Tool Model	COMPROB 4 PI
Tool SN	3083	Tool SN	5185	Tool SN	6009
From	SURFACE	From	278 FT	From	SURFACE
To	560 FT	To	560 FT	To	560 FT
Recorded By	M. QUINONES	Recorded By	M. QUINONES	Recorded By	M. QUINONES
Truck No	310	Truck No	310	Truck No	310
Operation Check	6-12-17	Operation Check	6-12-17	Operation Check	6-12-17
Calibration Check	6-12-17	Calibration Check	N/A	Calibration Check	N/A
Time Logged	10:45 AM	Time Logged	11:25 AM	Time Logged	11:45 AM
Date		Date		Date	
Run No.	4	Run No.	5	Run No.	6
Tool Model		Tool Model		Tool Model	
Tool SN		Tool SN		Tool SN	
From		From		From	
To		To		To	
Recorded By		Recorded By		Recorded By	
Truck No		Truck No		Truck No	
Operation Check		Operation Check		Operation Check	
Calibration Check		Calibration Check		Calibration Check	
Time Logged		Time Logged		Time Logged	
Additional Comments:					
Caliper Arms Used: N/A			Calibration Points: N/A		

Disclaimer:

All interpretations of log data are opinions based on inferences from electrical or other measurements. We do not guarantee the accuracy or correctness of any interpretations or recommendations and shall not be liable or responsible for any loss, costs, damages, or expenses incurred or sustained by anyone resulting from any interpretation made by any of our employees or agents. These interpretations are also subject to our general terms and conditions set out in our current Service Invoice.





FWS50-4Rx Full Waveform Sonic Tool SN 5185

Probe Top = Depth Ref.



Four Conductor MSI Probe Top

Probe Length = 2.71 m or 8.9 ft
Probe Weight = ~18.0 kg or 39.6 lbs

Sensors: Ceramic Piezoelectric in Polyurethane potting

Transmitter Frequency: ~20 kHz resonant frequency

Rx - Rx Spacing: 0.2 m (7.9 in)

Typically ran centralized with external bow spring centralizers.

Can only be collected in fluid.

Temperature Rating: 70 Deg C (158 Deg F)
Pressure Rating: 200 bar (2900 psi)

Rx-4 Tx - Rx4 Spacing = 1.2 m (47.2 in)

Rx-3 Tx - Rx3 Spacing = 1.0 m (39.4 in)

Rx-2 Tx - Rx2 Spacing = 0.8 m (31.5 in)

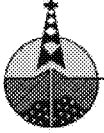
Rx-1 Tx - Rx1 Spacing = 0.6 m (23.6 in)

Acoustic Isolater

Tx = Acoustic Transmitter

0.155 m or 6.25 in. - End of tool to center of Tx

1.97" or 50 mm Diameter



**Southwest Exploration
Services, LLC**

borehole geophysics & video services

Well
Field
County
State

O-05
FLORENCE COPPER
PINAL
ARIZONA

Final

Sonic Summary

APPENDIX B

Geophysical Logs for Well O-05B

WELL O-05B

Geophysical Log Summary



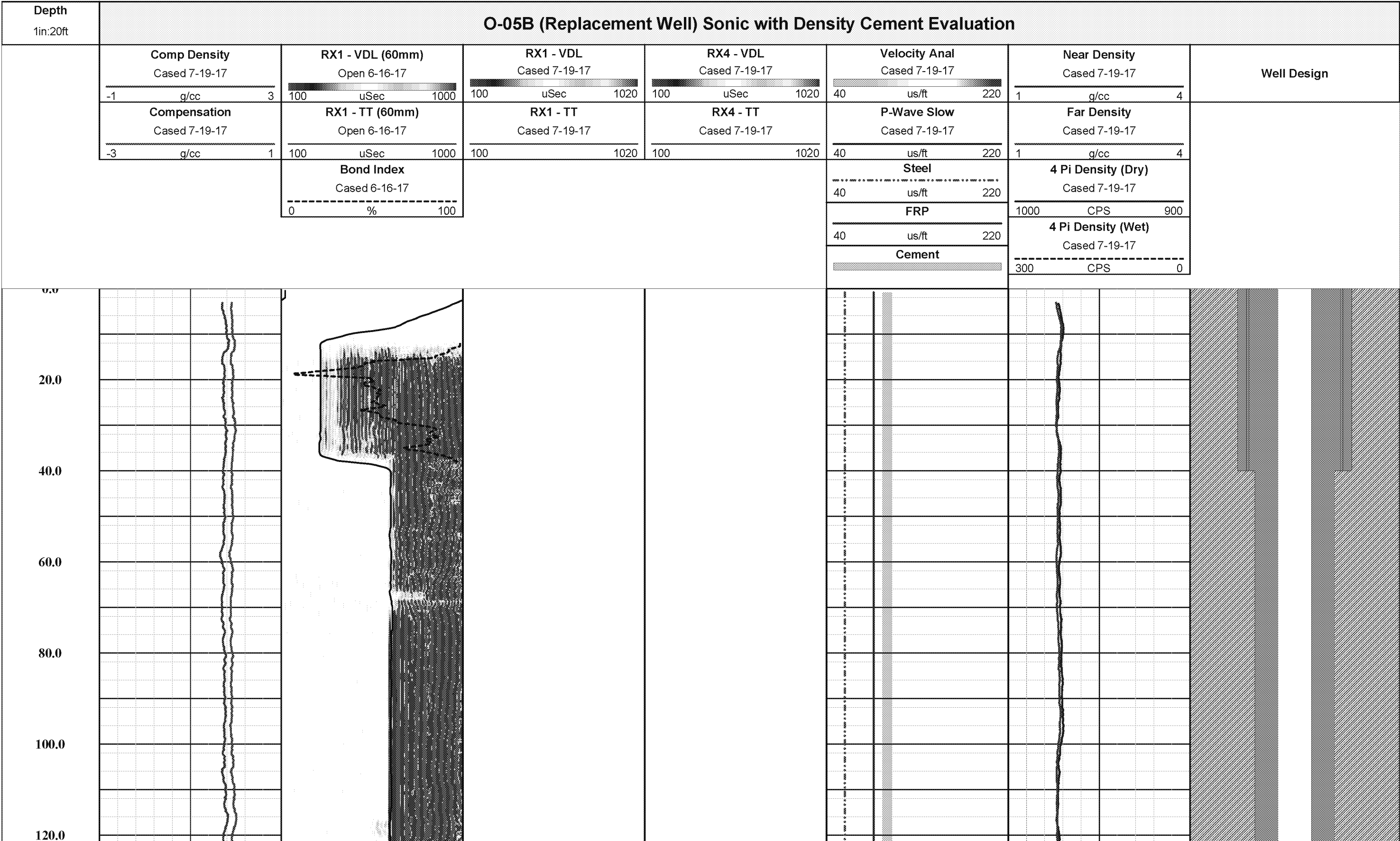
Southwest Exploration
Services, LLC

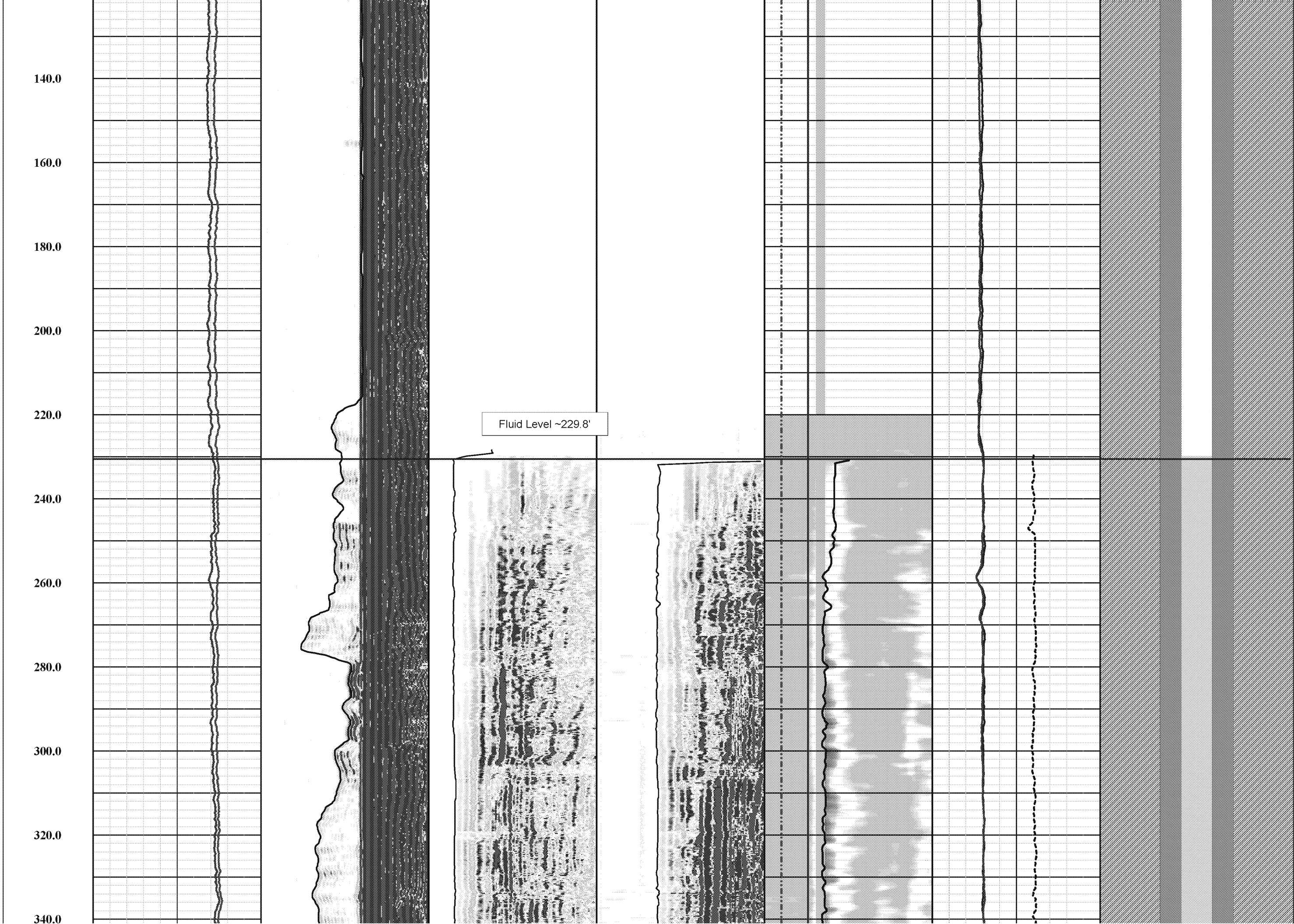
borehole geophysics & video services

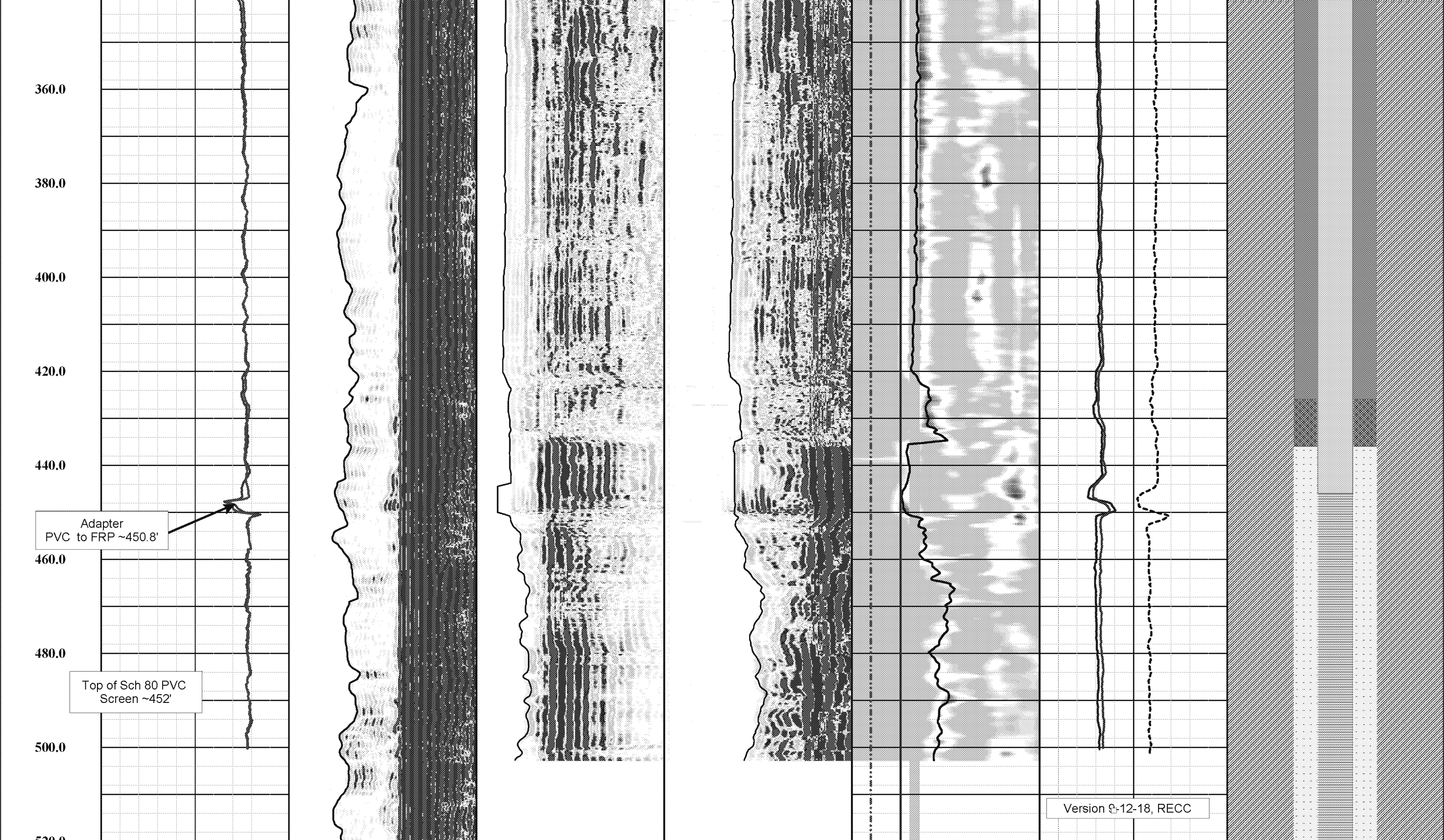


COMPANY: FLORENCE COPPER COMPANY
FIELD: FLORENCE COPPER SITE
WELL ID: O-05B
COUNTY: PINAL STATE: ARIZONA

Logging Engineer: K. MITCHELL
Date Logged: 12-03-17
Processed By: K.M / B.C.
Date Processed: 09-13-18







-3g/cc1		0%100		1001020		1001020		40us/ft220		300CPS0	
Cased 7-19-17		Cased 6-16-17		Cased 7-19-17		Cased 7-19-17		40us/ft220		Cased 7-19-17	
Compensation		Bond Index		RX1 - TT		RX4 - TT		FRP		4 Pi Density (Wet)	
		100uSec1000						40us/ft220		1000CPS900	
		Open 6-16-17						Steel		Cased 7-19-17	
		RX1 - TT (60mm)						40us/ft220		4 Pi Density (Dry)	
								Cased 7-19-17		1g/cc4	
								Cased 7-19-17		Cased 7-19-17	
								P-Wave Slow		Far Density	

	<div> <div>-1</div> <div>g/cc</div> <div>3</div> </div> <div>Cased 7-19-17</div> <div>Comp Density</div>	<div> <div>100</div> <div>uSec</div> <div>1000</div> </div> <div>Open 6-16-17</div> <div>RX1 - VDL (60mm)</div>	<div> <div>100</div> <div>uSec</div> <div>1020</div> </div> <div>Cased 7-19-17</div> <div>RX1 - VDL</div>	<div> <div>100</div> <div>uSec</div> <div>1020</div> </div> <div>Cased 7-19-17</div> <div>RX4 - VDL</div>	<div> <div>40</div> <div>us/ft</div> <div>220</div> </div> <div>Cased 7-19-17</div> <div>Velocity Anal</div>	<div> <div>1</div> <div>g/cc</div> <div>4</div> </div> <div>Cased 7-19-17</div> <div>Near Density</div>	Well Design
1in:20ft Depth	O-05B (Replacement Well) Sonic with Density Cement Evaluation						